

PATENT SPECIFICATION (11)

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(54) IMPROVEMENTS IN OR RELATING TO AN AGRICULTURAL MACHINE HAVING A WORKING IMPLEMENT ARRANGED TO BE MOVABLE IN HEIGHT

(71) We, MASCHINENFABRIK FAHR AKTIENGESellschaft GOTTMADINGEN of 7702 Gottmadingen, Germany, a German Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an agricultural machine having a working implement which is arranged to be movable in height, at least a part of the weight of said implement being supported by means of a lifting cylinder on the agricultural machine or on a towing vehicle and the lifting cylinder being connected by way of a multi-way valve to a hydro pump. The agricultural machine may be self-propelled or drawn or pushed.

With such agricultural machines, for example combine harvesters, many different arrangements are already known by which, when using a lifting cylinder i.e. of a hydraulic system, for the movement in height the functions "lift", "lower" and "neutral", and also a "release position" can be selected. Some of the valve arrangements provided for this purpose are quite complicated. They cannot in particular be used with tractor-drawn agricultural machines which have a movement in height, with which the three-way valve of the tractor hydraulic system has to be employed for operating the height movement for reasons of operation, simplicity and cost.

According to the present invention we provide an agricultural machine having a working implement arranged to be movable in height, at least a part of the implement weight being supported by means of a lifting cylinder on the agricultural machine, the cylinder being connected by a multi-way valve to a hydro-pump, wherein a valve system is connected between the lifting cylinder and the multi-way valve, the said valve system consisting of a non-return valve which is open only upon feeding of the lifting cylinder with the pressurizing medium and a pressure-limiting

valve which prevents the pressure of said medium in said cylinder falling below a predetermined level and is arranged in shunt with the non-return valve, and a hydropneumatic storage unit connected to the hydraulic pipe between the pressure limiting valve and the lifting cylinder.

As regards a hydropneumatic storage unit, this is a housing which is closed on all sides and which can be connected with hydraulic pipes. Fixed inside the housing is a resilient diaphragm on the inside wall facing the hydraulic pipe connection. The space closed off by the diaphragm is filled with a gas, so that the diaphragm bears against the said inside wall of the housing of the hydropneumatic storage unit under the influence of the gas pressure, which unit is thus filled with gas having a certain filling pressure. If now the hydraulic pressure effective at the connection of the storage unit exceeds this filling pressure, then the gas is compressed and pressurised medium flows into the storage unit until a pressure balance is once again produced because of the reduction in volume or the compressibility of the gas.

By the use of such a hydropneumatic storage unit for improving the hydraulic lifting system, the result is obtained that, in the "lower" position of the multi-way valve, there is *per se* an emptying of the storage unit so that with the implement in the vicinity of the ground the storage unit is completely empty. If the implement, e.g. a rotary mower or reaper, has to be quickly raised by adjusting the "lift" position of the valve in the event of an obstruction or the like, then first of all the emptied storage unit is filled and thus the lifting operation is retarded in such a manner as to be no longer sufficient for counteracting any damage to the implement or to the obstacle which appears, in view of the relatively high working speeds of the agricultural machines, more especially of rotary mowers. This disadvantage is however effectively avoided by the construction as indicated above, since the return pressure medium flow from the

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lifting cylinder is prestressed under all circumstances by the action of the pressure-limiting valve, so that a corresponding pressure or a corresponding filling remains in the storage unit. As a result, firstly the degree of relief at the hydraulic lifting system, i.e. that portion of the weight of the vertically movable parts of the agricultural machine taken up by this system, is reduced, and secondly the response time of the hydraulic lifting system to the order "lift" is reduced. The smaller the degree of relief, the smaller is also the response time.

Since now only one non-return valve is provided for the pressure medium e.g. oil, feed in addition to the hydropneumatic storage unit and the pressure-limiting valve, the oil return flow must in every case pass through the pressure-limiting valve, so that the hydropneumatic storage unit is only partially emptied, providing a lower degree of relief and a short response time.

Valves and storage unit are preferably assembled together to form a single structural component in a piping-free compact arrangement. This reduces the space requirement on the agricultural machine which can be movable in height and in addition the liability of breakdown is also reduced, since no hydraulic pipes are to be provided which could in certain circumstances break on the agricultural machine with rough field work and could make the lifting system incapable of operating. In addition, there is also obtained a reduction in cost as regards material and assembly.

Preferably, the structural component consists of a block, in which are disposed bores parallel to one another, one of said bores being formed as a non-return valve which can be released mechanically and the other as a pressure-limiting valve. Such a block is less susceptible to damage and can be fitted on the agricultural machine. It has relatively small dimensions and can be easily manufactured.

The bores which are parallel to one another can be extended to the surface of the block for adjustment and measurement purposes. At the surface, they can be closed off by plugs, screws or the like, possibly with a sealing action. At the same time, however, they are readily accessible, insofar as the adjustment of the pressure-limiting valve, the connection of pressure gauges or the like are concerned. Assembly is also simplified.

The use of an adjustable pressure-limiting valve is particularly expedient, because it is possible thereby to select the correct degree of relief or pretensioning value in accordance with particular requirements at the time. In addition, a suitable adaptation is possible after necessary modifications or with different working ranges of the operat-

ing implement on the part of the agricultural machine which is movable in height. The possibility of adjusting the pressure-limiting valve is most easily achieved by providing a spring-loaded valve member, for example, a ball resting on a valve seat, it being possible to influence the pretension of the spring by a set screw.

For the connections of the valves formed in the block in the manner as above described, two additional bores which are parallel to one another are preferably formed in the block, these latter bores being disposed perpendicular to the other pair of bores and being arranged in the same plane of the structural group, intersecting the said pair. In this way, extremely short connecting paths are formed. The connecting pipes of the valves to one another and to the hydraulic lifting system are arranged inside the block. Piping systems and hydraulic pipes are thus not necessary for this purpose.

The additional bores are preferably led out to one surface of the block to serve as connections for the lifting cylinder and the hydropump (the latter by way of the multi-way valve). Since the pairs of bores lie perpendicular to one another, the surface concerned is a surface not so far used for connections, plugs and the like, and this further contributes to the compact nature of the arrangement.

On the opposite surface, the hydropneumatic storage unit can be flanged on to the other end of the bore which serves as connection for the lifting cylinder. Consequently, this storage unit is also connected without use of piping and in addition is held by the valve block itself. It is accordingly sufficient to fix this block on the agricultural machine. A separate fixing for the hydropneumatic storage unit is no longer necessary.

The block itself is advantageously made of parallelepipedic form, since this form provides particularly favourable fixing possibilities because of large bearing surfaces, for example, of one large side of the parallelepipedic block, and simultaneously favourable connection possibilities, for example, at the four narrower sides of the parallelepipedic block.

Particular embodiments of the invention will now be described by way of example only with reference to the accompanying drawings, wherein:—

Figure 1 is a diagrammatic elevation of the hydraulic lift system, and

Figure 2 is a preferred embodiment of the structural group comprising the valve and storage unit.

Figure 1 shows diagrammatically a tractor-drawn agricultural machine, a frame 1 of which agricultural machine bears by way of wheels 2 on the ground surface 3. An

implement carrier 4, which carries at least one revolving reaping or mowing member 5, is articulated on the frame 1 of the agricultural machine so as to be movable in height. An implement carrier 4 is supported on the frame 1 of the agricultural machine by way of a lift cylinder 6, which is in its turn articulated on the implement carrier and on the frame 1. The said cylinder 6 is constructed as a hydraulic cylinder. In the constructional example which is illustrated, the piston rod of the piston in the hydraulic cylinder is articulated on the implement carrier 4, while the hydraulic cylinder itself is articulated on the frame 1.

With tractor-drawn agricultural machines which are adjustable in height, the hydraulic system of a tractor 7 which is indicated in Figure 1 is used for feeding the lift cylinder 6. The hydraulic system of the tractor comprises a hydropump 8 and a conventional three-way valve 9. A tank 10 and a hydraulic pipe 11 are also provided, to which the hydraulic system of the tractor-drawn agricultural machine can be connected. The symbols shown in hydraulic line 11 although similar to that denoted by 15 as a non-return valve do not signify non return valves but merely denote connection fittings to enable the required connection to be made. The connection is effected by way of an expansion member 12 or coupling which is only indicated symbolically in Figure 1 and comprises a flexible conduit or respectively a section of the hydraulic pipe which is variable in length.

Arranged between the expansion members 12 and a hydraulic pipe 13 of the lift cylinder 6 is a structural group consisting of a hydropneumatic storage unit 14 and a valve system. The hydropneumatic storage unit has in its interior a resilient diaphragm, by which a gas volume enclosed in the hydropneumatic storage unit 14 and the pressure oil volume in said unit are separated from one another. The hydropneumatic storage unit is connected to the hydraulic pipe 13 between the lift cylinder 6 and the valve system.

The valve system consists of a non-return valve 15 freeing the path for the oil to the hydraulic pipe 13 and to the lift cylinder 6, and in shunt with the valve 15, there is provided an adjustable pressure-limiting valve 16 for prestressing the return flow of oil. A shut-off cock 17 indicated in broken lines serves for assembly purposes and is of no significance for use in operation or for transport.

The functional symbols of the hydraulic lifting system which are indicated in Figure 1 are familiar to the expert. The functioning of the arrangement can moreover be readily appreciated from Figure 1 and does not require any further explanation.

Figure 2 shows the structural group in detail, in which the valve system and storage unit are combined in a compact structure free from any interconnecting pipes. The valve system consists of a block 18, which can have a square outline and can be of a smaller height than the side edges of its base surface. Formed in the block 18 are bores 19 and 20 which are parallel with one another and are formed in the block 18 from sides which are opposite one another. The bore 19 is constructed as a non-return valve 15 which can be mechanically released by means of a threaded bolt sealed off by an O-ring or as a shut-off cock while the bore 20 is constructed as an adjustable pressure-limiting valve 16. Serving in each case as valve member is a ball moving against a valve seat. The valve member of the pressure-limiting valve 16 is loaded by a spring 21, of which the pretension is adjustable by means of a set screw 22. For this purpose the set screw 22 can be screwed in an internal thread of the corresponding bore 20. It can be secured in its respective position by a small clamping screw 23. Access to it is provided by the fact that the bore 20 is closed on this side by a closure screw 24 with a sealing ring. The opposite end of the bore 20 has a known connecting union which is covered with a knurled cap 25 and to which can be connected a pressure gauge or the like for detecting the pressure in the hydraulic pipe 13 to the lifting cylinder 6 and in the hydropneumatic storage unit 14. The bores 19 and 20 are in other respects constructed and shut off in the manner which is shown in Figure 2.

In addition, two other bores 26 and 27 which are parallel to one another are formed in the block 18, the said bores lying perpendicular to the bores 19 and 20 and, intersecting these latter, in the same plane of the structural group. The bores 26 and 27 lead out to a pump connection 28 and to a lifting cylinder connection 29, respectively, at one surface of the block 18.

The bore 27 of the block 18, which bore is connected to the lifting cylinder 6 by way of the lifting cylinder connection 29 and partially representing the hydraulic pipe 13, extends to the opposite side of the block, where the connecting flange 30 of the hydropneumatic storage unit 14 is disposed at its other end. The different connections or unions are thus distributed around the block 18 and easily accessible. The two large surfaces of the parallelepipedic block 18 are available for mounting the block on the frame 1 of the agricultural machine and thus provide for a solid fixing. This can for example be effected by screw bolts, which extend through bolt holes 31 and 32.

If the mowing mechanism according to Figure 1 is to be brought into the operative

position, the multi-way valve 9 is brought into the "lower" position. The mowing mechanism is moved slowly downwards. The oil displaced by the piston of the lifting cylinder 6 is able to flow through the pressure-limiting valve 16 and the multi-way valve 9 into the tank 10. The pressure-limiting valve 16 closes as soon as the mowing mechanism bears on the ground. The multi-way valve 9 is once again brought into the neutral or blocking position, as shown in Figure 1. If now the mowing mechanism passes through a depression in the ground, the oil is compressed in the cylinder 6. The pressure-limiting valve 16 cannot become operative, because the discharge of the oil is prevented by the neutral position of the multi-way valve. The quantity of oil displaced by the piston of the lifting cylinder is forced into the hydropneumatic storage unit 14. This stored energy can be delivered again for the lifting or the ascent of the mowing mechanism from the ground depression. In this way, a particularly sensitive control and guiding of the mowing mechanism over unevennesses on the ground is achieved.

Thus, as described above, it is possible to equip the agricultural machine in a simple and inexpensive manner, so that a functioning of the height movement complying with all requirements is easily produced.

WHAT WE CLAIM IS:—

1. An agricultural machine having a working implement arranged to be movable in height, at least a part of the implement weight being supported by means of a lifting cylinder on the agricultural machine, the cylinder being connected by a multi-way valve to a hydropump, wherein a valve system is connected between the lifting cylinder and the multi-way valve, the said valve system consisting of a non-return valve which is open only upon feeding of the lifting cylinder with the pressurizing medium and a pressure-limiting valve which prevents the pressure of the said medium in the said cylinder falling below a predetermined level and is arranged in shunt with the non-return valve, and a hydropneumatic storage unit connected to the hydraulic pipe between the pressure limiting valve and the lifting cylinder.

2. An agricultural machine according to

Claim 1, wherein the said valve system and the storage unit are assembled to form a single structural part in a construction free from piping.

3. An agricultural machine according to Claim 2, wherein the valve or valve system consists of a block in which are disposed bores which are parallel to one another and of which one is formed as the non-return valve which can be freed mechanically and the other is constructed as the pressure-limiting valve.

4. An agricultural machine according to Claim 3, wherein the bores which are parallel to one another are carried through to the surface of the block for adjustment and measurement purposes.

5. An agricultural machine according to Claim 3 or Claim 4, wherein two additional bores which are parallel to one another are formed in the block these bores being disposed at right-angles to the other pair of bores and in the same plane of the structure part while intersecting the said pair.

6. An agricultural machine according to Claim 5, wherein the additional bores are both led out as connections for the lifting cylinder and the pump at the same surface of the block.

7. An agricultural machine according to Claim 6, wherein the hydropneumatic storage unit is flanged on the surface opposite the said surface on to the other end of the bore which is the lifting cylinder connection.

8. An agricultural machine according to any one of Claims 3 to 7, wherein the block is made of parallelepipedic form.

9. An agricultural machine according to any one of the preceding claims, wherein the pressure-limiting valve is adjustable.

10. An agricultural machine according to Claim 9, wherein the pressure-limiting valve has a spring loaded valve member and the pretension of the spring can be influenced by a set screw.

11. An agricultural machine substantially as herein described with particular reference to the accompanying drawings.

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Fig.1

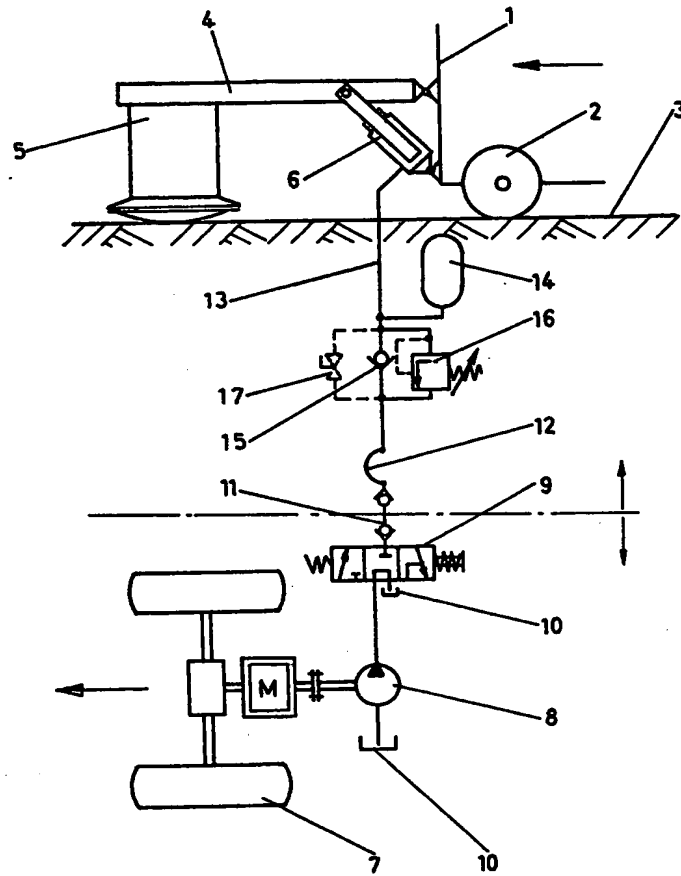


Fig. 2

